Statistics report

Energy Technology RD&D Budgets

Overview

2020

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The IEA Energy Technology Research, Development and Demostration (RD&D) data collection and the analysis presented in this paper were performed by Domenico Lattanzio and Alexandre Bizeul under the responsibility of Roberta Quadrelli, in the IEA Energy Data Centre headed by Nick Johnstone. Simon Bennett, Simone Landolina and Jean-Baptiste Le Marois also contributed to this analysis. We would like to thank our numerous contacts in national administrations for their helpful co-operation.

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Source: IEA Energy Technology RD&D Budgets (2020 first edition)

Further information on RD&D statistics, including a downloadable database, is available at:

https://www.iea.org/subscribe-to-data-services/energy-technology-rdd.

The content of this overview is available at:

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In addition, a wide range of free energy statistics can be accessed at: www.iea.org/statistics.

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https://webstore.iea.org/energy-technology-rdd-budgets-2020-overview.

This database is a component of the broader IEA work on innovation tracking and policy, which includes analysis of investment and innovation trends as part of the IEA's work on *Tracking Clean Energy Progress* (https://www.iea.org/tcep/), *World Energy Investment* (https://www.iea.org/topics/investment/), the IEA Technology Network of 6 000 experts worldwide (https://www.iea.org/tcp/) and the Clean Energy Transitions Programme (https://www.iea.org/cetp/).

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Notes:

This report presents data on public energy (RD&D) expenditures collected by the IEA. It includes central or federal government budgets as well as expenditures by state-owned companies.

Unless otherwise specified, this publication refers to total public energy RD&D expenditure data, converted from current prices in national currencies to US dollar (USD) Purchasing Power Parities (PPP) in constant 2019 prices, using GDP deflators and 2019 PPPs. The use of PPPs eliminates the differences in price levels between countries that are not reflected in nominal exchange rates. For more information on PPP methodology see www.oecd.org/std/prices-ppp/.

Data for the latest year (2019) are available for: Australia, Canada, Estonia, Germany, Hungary, Japan, New Zealand, Norway, Poland, Slovak Republic, Sweden, Switzerland, the United States and the European Union. For the other countries, the latest data refer to 2018. For Czech Republic, Greece and Luxembourg, no recent data are available. Data for the United States for the years 2016-2019 have been estimated by the IEA Secretariat. To produce regional aggregates, missing country data have been estimated by the IEA Secretariat.

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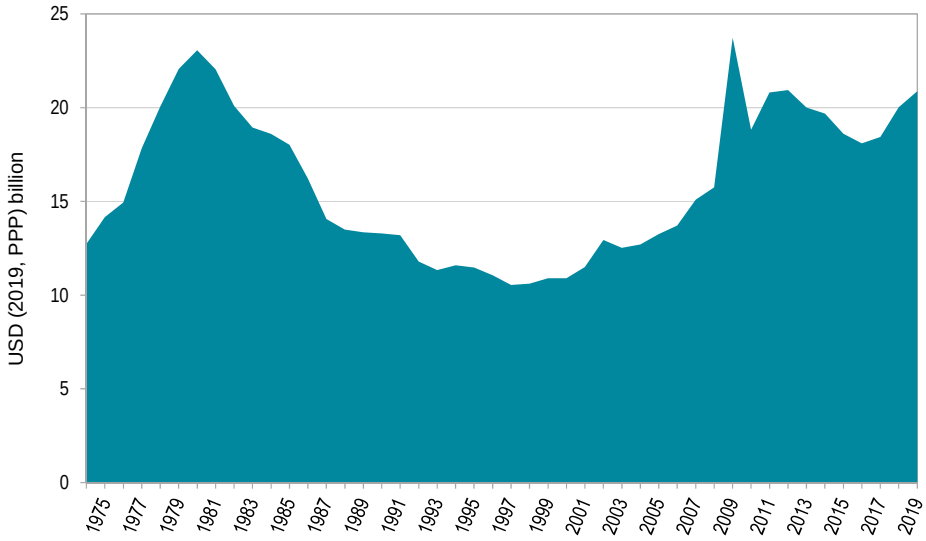
KEY TRENDS IN IEA PUBLIC ENERGY TECHNOLOGY RESEARCH, DEVELOPMENT AND DEMONSTRATION (RD&D) BUDGETS

Part I. Overview of public energy RD&D trends in IEA countries

In 2019, the estimated total public energy research, development and demonstration (RD&D) budget for IEA member countries increased by 4% reaching USD 20.9 billion (Figure 1)[1]. This was the third consecutive year of increase after four years of decrease; the 2019 level was one third higher than in 2008 and comparable to that of 2012, although much lower than the 2009 peak.

Figure 1: IEA member countries total public energy RD&D budget*



* PPP = purchasing power parity. USD 22.5 billion in 2009 is an outlier related to the American Recovery and Reinvestment Act (stimulus) spending, which was allocated to the 2009 budget year. Data from 2018 onwards include for spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion of low-carbon technologies in 2018), which is not covered for previous years. This has effects on the apparent 2017-2018 growth.

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[1] All data in this publication are expressed in 2019 prices and purchasing power parity, or PPP, terms, unless otherwise specified. The total IEA budget does not include the European Union funding under the Horizon 2020 programme (USD 2.3 billion in 2019).

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In PPP terms, the United States and Japan spent the most on energy RD&D among IEA member countries (Figures 2 and 3), followed by Germany, France the United Kingdom, Canada, Korea, Italy and Norway. The expenditure increased in 2019 for all those countries except Japan, where it fell by 2%. The figures also include the energy RD&D budget of the European Union under the Horizon 2020 programme, which is larger than that of all but two IEA member countries: the United States and Japan.

Figure 2: Public energy RD&D budgets by country for IEA members and the European Union*

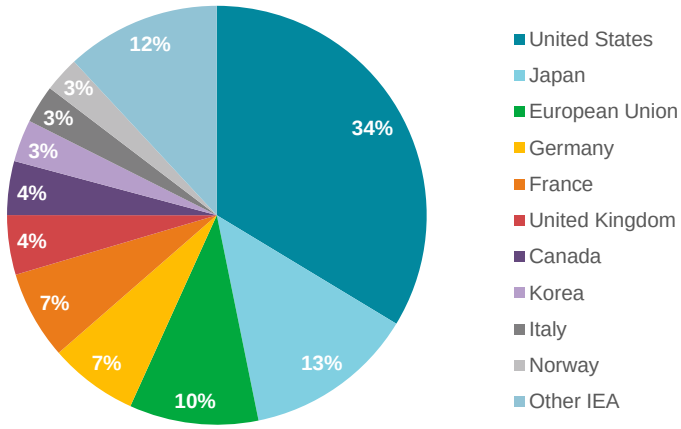
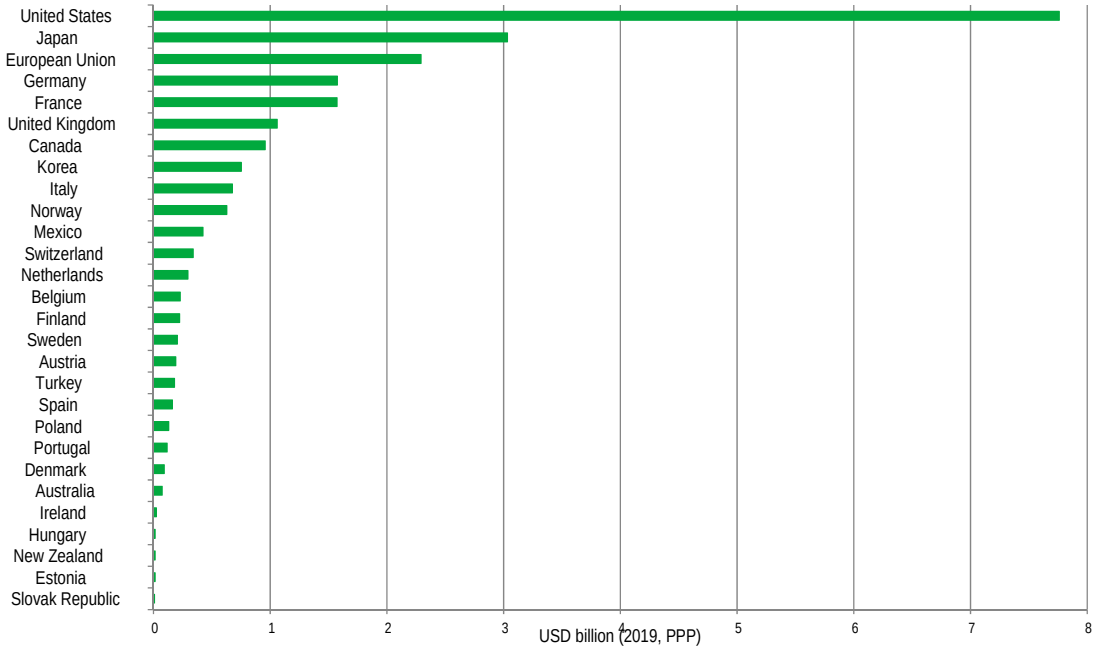


Figure 3: Total public energy RD&D budgets by country for 2019 or latest availabe year*



* The amounts shown are based on 2019 energy RD&D budgets for: Australia, Canada, Estonia, Germany, Hungary, Japan, New Zealand, Norway, Poland, Slovak Republic, Sweden, Switzerland, the United States and the European Union. For the other countries, data refer to 2018. Data for the United States were estimated by IEA Secretariat. European Union refers to the European Union budget under Horizon 2020, and not to the sum of national budgets of European Union member countries.

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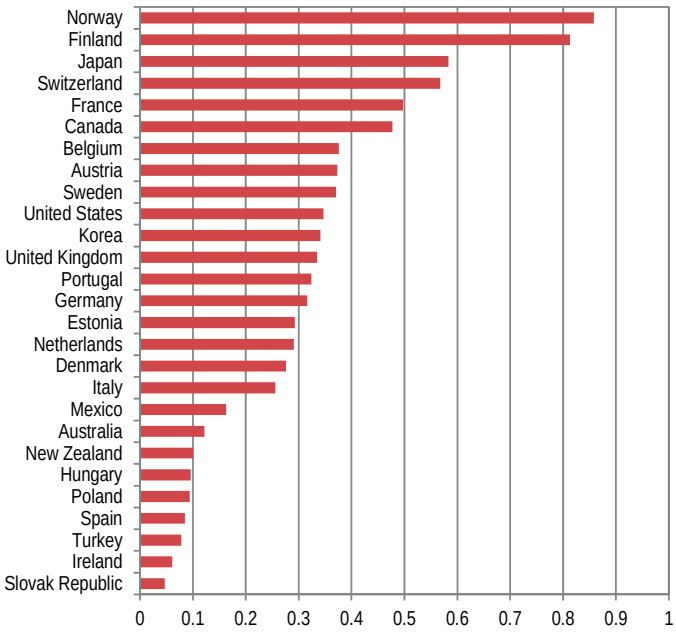
Public energy RD&D budget per unit of GDP varied greatly among IEA member countries, approximately ranging from 0.1 to 1 per thousand in 2018 (Figure 4). Norway had the highest level (0.86 per thousand), followed by Finland (0.81). Other leading countries were Japan (0.58), Switzerland (0.57) and France (0.50).

Figure 4: Total public energy RD&D budgets per thousand units of GDP by country for 2018*



* Total RD&D in nominal national currencies divided by GDP in nominal national currencies at market prices and volumes, expressed in thousand units of GDP. Based on 2018 data. No recent data were available for Greece, Luxembourg and Portugal. Data for the United States have been estimated by the IEA Secretariat.

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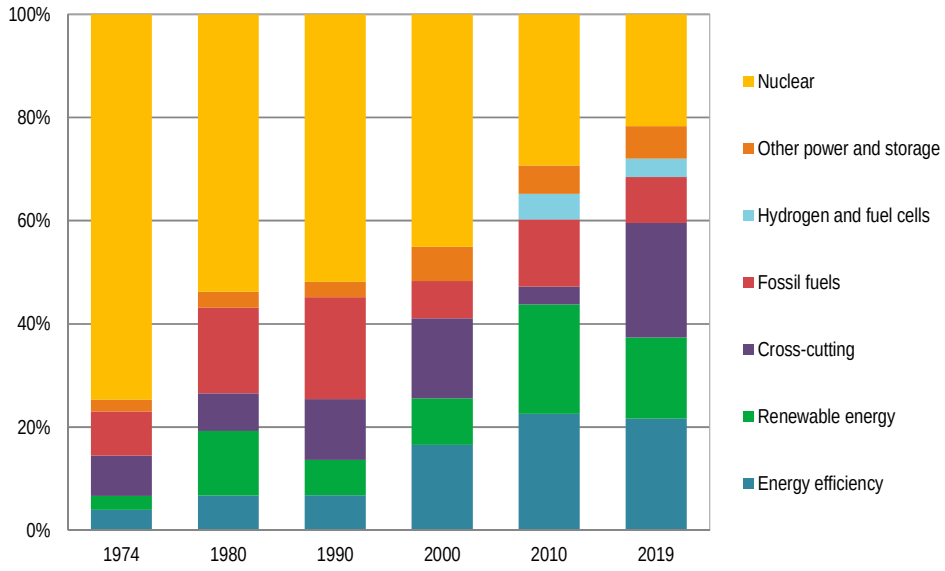
Part II. Public energy RD&D trends across technologies in IEA Countries

Over the last 40 years, investment from IEA member countries in energy RD&D has become progressively more diverse (Figure 5). Nuclear power, dominant in 1974 with 75% of total public energy RD&D budget, witnessed year-to-year reductions to reach 21% in 2019, a share comparable to energy efficiency (21%), renewables (15%) and cross-cutting RD&D (23%). RD&D budgets on fossil fuels, which were at their highest in the 1980s and early 1990s, have declined since 2013 (15%) to 9% in 2019.

Budgets for both energy efficiency and renewables grew significantly during the 1990s and 2000s, rising from 7% each in 1990 to 23% and 21% respectively in 2010. Since then, the share of energy efficiency has remained almost constant, whilst the share of renewables has declined to 15%. On the other hand, cross-cutting RD&D[2] grew in the first decade of the 21st century. Budgets for hydrogen and fuel cells kept their share at 3% since 2012.

Figure 5: Evolution of IEA total public energy RD&D by technology



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[2] Almost half of the 2019 US budget was allocated to cross-cutting energy technologies and could not be broken down further. The cross-cutting category mainly corresponds to what the US Department of Energy, Office of Science, reports under its Basic Energy Sciences

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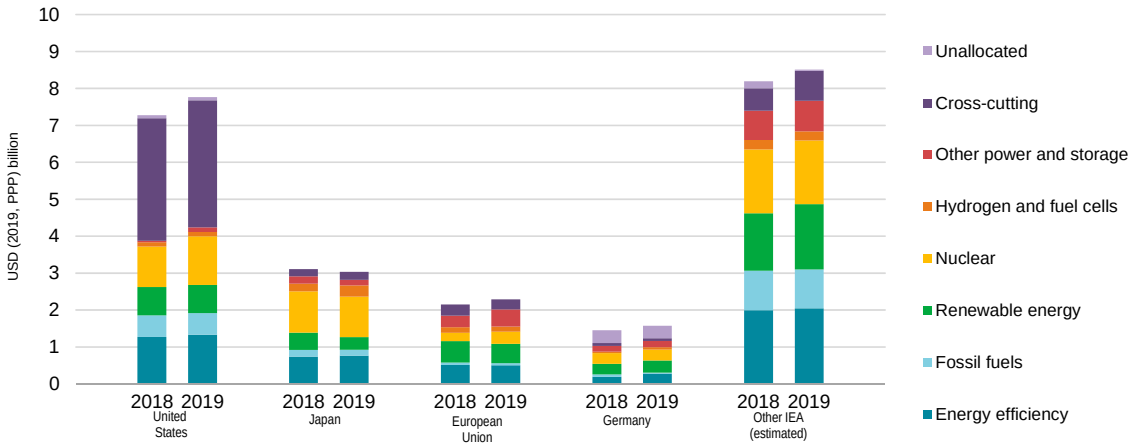
In 2019, the United States overcame Japan with the largest RD&D budget for nuclear (USD 1314 million), while Japan remained by far the highest funder of hydrogen and fuel cells research (USD 297 million) (Figure 6). In 2019, the European Union spent almost a quarter of its budget on the other power and storage technology (USD 461 million) being for this technology category a larger funder than any IEA country. For all the remaining technologies, the United States spent the highest budget.[3]

In 2019, the budget increased for all types of technology except for fossil fuels, which decreased by 4%. The highest increase was 18% for hydrogen and fuel cells which followed an increase of 25% recorded in 2018. The budget allocated to renewables significantly grew in Other IEA (14%), overpassing nuclear, mainly thanks to Norway, which increased renewable budget more than four-fold with the demonstration project of a floating off-shore wind plant[4] (USD 242 million for off-shore wind demonstration).

Figure 6: 2018 and 2019 budgets by technology in selected IEA countries and the European Union*



* European Union refers to the European Union budget under Horizon 2020, and not to the sum of national budgets of European Union member countries. Data for the United States have been estimated by the IEA Secretariat.

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[3] Data for the United States have been estimated by the IEA Secretariat for 2016-2019.

[4] For further information about the project please refer to: https://www.regjeringen.no/en/aktuelt/enova-stotter-equinors-demonstrasjonsprosjekt-for-flytende-havvind/id2666182/.

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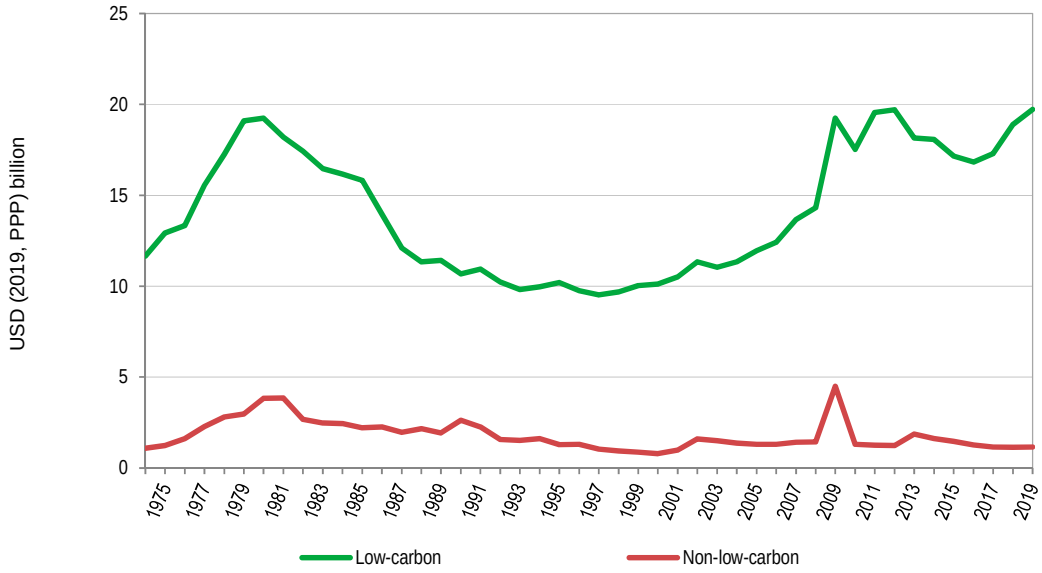
Part III. Public low-carbon energy RD&D trends in IEA countries

In 2019, public spending in low-carbon[5] energy technologies RD&D significantly increased in IEA member countries to reach USD 19.7 billion and 94% of total budgets (Figure 7), driving the third consecutive annual increase of total spending, after four years of decreases. Spending for non-low-carbon[6] energy technologies stabilised to the 2018 levels just above USD 1 billion.

Figure 7: Evolution of public low-carbon energy RD&D budget in IEA member countries*



* Data from 2018 onwards include for the additional spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion of low-carbon technologies in 2018), which is not covered for previous years. This has effects on the apparent 2017-2018 growth.

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In line with this trend, most individual countries increased in 2019 their investments in low-carbon RD&D (Figure 8). In the United States, low-carbon energy RD&D budgets were estimated to grow by 7% with an additional USD 479 million; the second largest increase was in Norway (additional USD 242 million, linked to the wind demonstration project mentioned above). In an opposite trend to most countries, Japan decreased its low-carbon budget by 2%.

[5] In the current IEA categorization of RD&D energy technologies, low-carbon energy technologies are defined as: energy efficiency, carbon capture and storage (CCS), renewable energy sources, nuclear, hydrogen and fuel cells, other power and storage, and other cross-cutting technologies and research.

[6] In the current IEA categorization of RD&D energy technologies, non-low-carbon energy technologies represent coal, gas, oil and other fossil fuel RD&D, excluding CCS.

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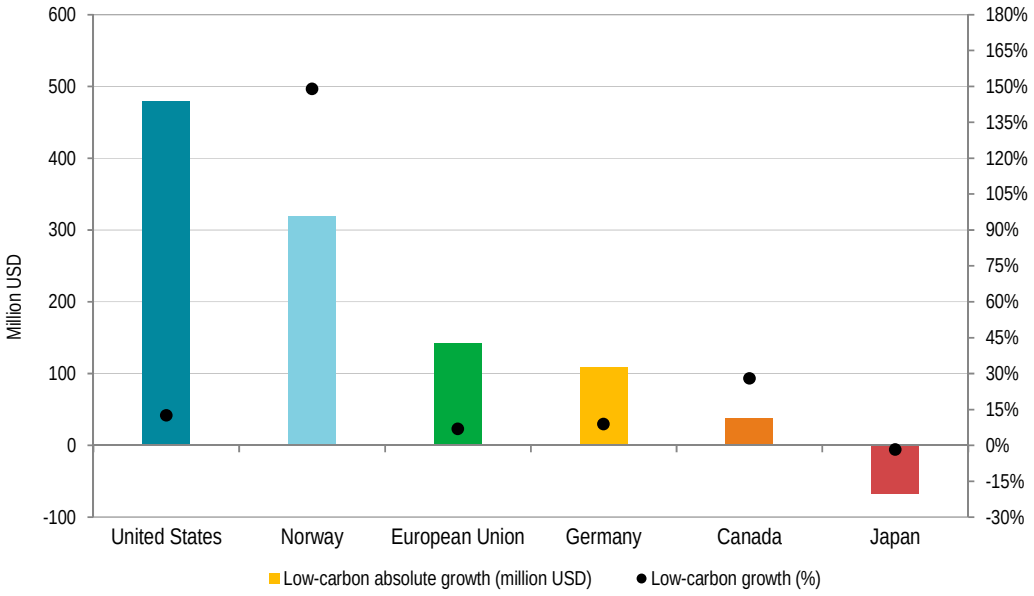
Figure 8: Variations in public low-carbon energy RD&D budgets for selected IEA countries and the European Union in 2019*



* Data for the United States have been estimated by the IEA Secretariat for 2016-2019.

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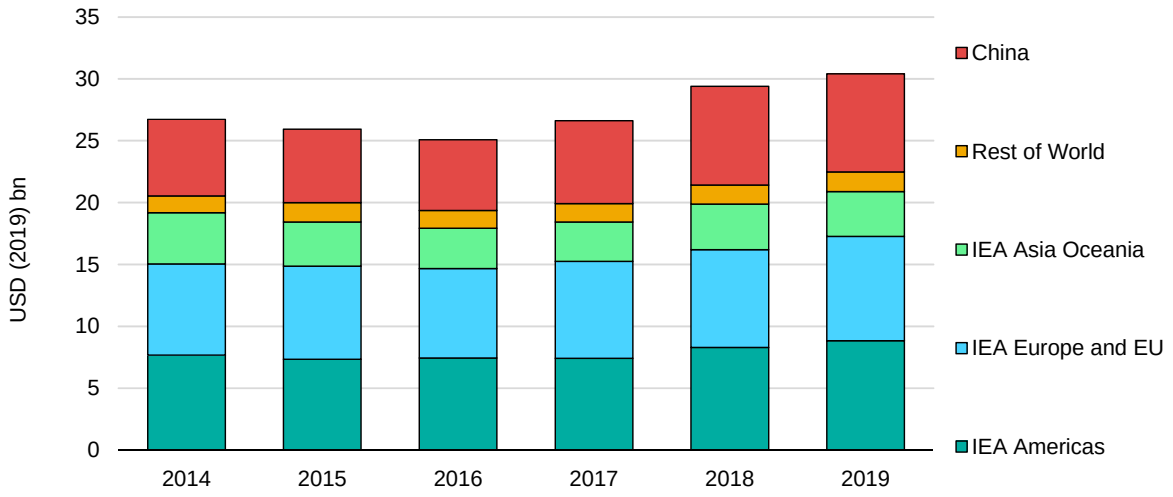
Part IV. Global energy RD&D trends

IEA's work on energy innovation under the World Energy Investment report[7] and the Clean Energy Transitions Programme (CETP) complements the collection and dissemination of IEA member country RD&D budget data by assembling available information on non-IEA government energy RD&D spending and private sector energy R&D spending trends[8], in a sustained effort to increase coverage beyond official data submissions to the IEA.

In 2019, the estimated global public energy RD&D budget reached about USD 30.4 billion[9] (Figure 9), confirming the increasing trend since 2017 after several years of decline. The growth was mostly supported by Europe and the United States, while public spending in energy R&D stabilised in China after two years of strong growth and ahead of the country's next five-year plan.

Figure 9: Global public energy RD&D budget*



* Data for non-member countries are estimated based on public sources and are subject to revisions over time. Data for 2018 include for the first time the additional spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion), which is not covered for previous years. This has effects on the apparent 2017-2018 growth. *IEA Asia Oceania* includes Japan, Korea, Australia and New Zealand. *IEA Europ and EU* includes Austria, Belgium, the Czech Republic, Denmark, Estonia,Finland, France, Germany, Greece, Hungary, Ireland, Italy,Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the European Union. *IEA Americas* includes Canada, Mexico and the United States.

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Under Mission Innovation (MI), fifteen IEA member countries and the European Union, as well as key emerging economies such as Brazil, China, India, and Indonesia, pledged in 2015 to seek to double public clean energy R&D spending over five years. While there are differences between IEA and MI classifications and countries, IEA data show that estimated global public low-carbon energy RD&D spending rebounded in 2016 following two years of decline, and it has been on the rise since then, reaching a new high in 2019 at about USD 25.0 billion (Figure 10). Similarly to total spending, this growth was driven by increasing budgets in Europe and the United States, followed by China. Notably, public spending in low-carbon energy R&D grew faster than total energy R&D budgets, at a nearly 6% year-on-year growth rate.

[7] The next release of the IEA World Energy Investment (WEI) report is scheduled for June 2020.
[8] Updated estimates of corporate energy R&D spending and data for 2019 will be released in the IEA World Energy Investment (WEI) 2020 report.
[9] In this section, figures are based on 2019 prices and exchange rates (not PPP) terms.

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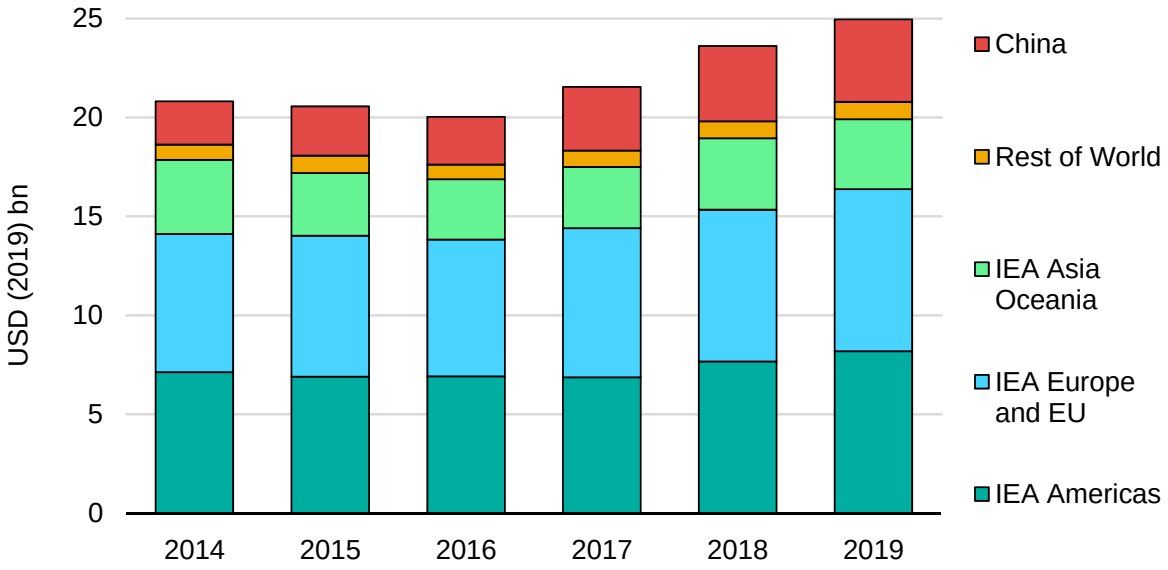
These encouraging trends, however, warrant further examination in 2020-21 as the impacts of the Covid-19 pandemic on global energy systems, including on public low-carbon energy R&D budgets, unfold.

Figure 10: Global public low-carbon energy RD&D budget*



* Data for non-member countries are estimated by the IEA based on public sources and are subject to revisions over time. Data for 2018 include for the first time the additional spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion), which is not covered for previous years. This has effects on the apparent 2017-2018.

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Corporate energy R&D spending[10]

Published data for R&D budgets by listed corporations globally show that these are the largest single source of funding for energy R&D, despite lower spending in recent years. The sample of listed companies active in energy technology sectors for which 2018 data is currently available increased their annual energy R&D spending, by around 4% (including automakers) (Figure 11). The total energy R&D spending of this sample reached nearly USD 94 billion in 2018. Excluding transport, a third of the total corporate energy R&D is estimated to have been allocated to low-carbon sectors.

Corporate R&D spending by companies in the oil and gas and other fossil fuel extraction sectors showed 1% growth in real terms in 2018, the first increase in R&D spending in this sector since 2014. Spending remains 45% below 2014 levels, however, and is not rising significantly as a share of revenue.

While the rebound of oil and gas company R&D budgets is sluggish, that of electricity generation and supply companies continues to rise. Siemens and General Electric occupied the top spots in the list of the highest global energy R&D spenders, with Petrochina dropping out of the top three for the first time in a decade. Four of the top ten are Chinese companies, and five are in the electricity sector.

[10] This section presents trends and findings up to 2018 which were published in WEI-2019 as well as in the IEA Energy Technology RD&D budgets publication from October 2019. Updated time series and data for 2019 will be published in WEI-2020.

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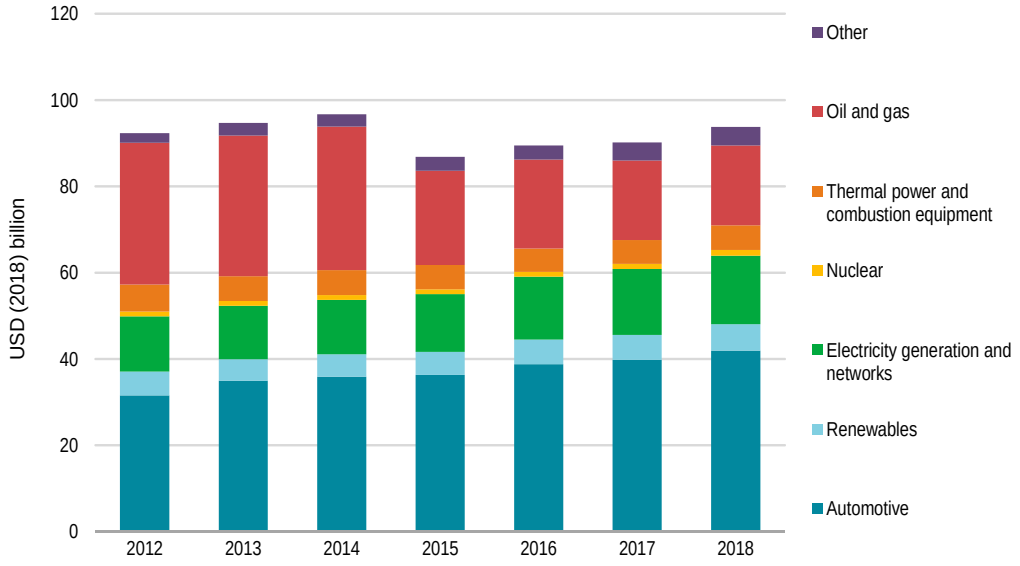
Figure 11: Global corporate R&D spending in energy-related sectors



Notes: Classifications are based on Bloomberg Industry Classification System. All publicly reported R&D is included, though companies domiciled in countries that do not require disclosure of R&D spending are under-represented. To allocate R&D spending for companies active in multiple sectors, interviews with company decision-makers and, in the absence of other data sources, the shares of revenue per sector were used. "Other" comprises carbon capture utilization and storage, electricity storage, insulation, lighting, other fossil fuels and smart energy systems.

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Automakers – who typically have much higher R&D budgets than energy companies in absolute terms and as a share of revenue – continue to increase their R&D spending as government policies and competitive pressures drive higher spending on energy efficiency and electric vehicles. Automakers' were the biggest contributors to the growth in corporate energy R&D spending technologies in 2018. This trend is notable among major European and US car and auto parts companies, whose R&D spending rose by around 7% on average in 2018, compared to 4% for Japanese and Korean firms. However, the increasingly global presence of Chinese automakers is reflected in their R&D spending, which rose more than 20% on average.

Unlike public R&D, many of the major companies active across the energy system devote no more than one-tenth to one-third of their total R&D budgets to new technologies, with the bulk of spending going to incremental improvements of existing technologies and product development.

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